NISTTech

Josephson Junction Digital-to-Analog Converter for Accurate AC Waveform Synthesis

Precision instrument for directly measuring AC voltages

Description

Achieves high precision measurements of AC currents by using arrays of Josephson junctions. A Josephson junction consists of two superconducting pieces of metal separated by a thin insulator or normal metal. When a fixed DC voltage is applied across it, a junction responds by generating an AC current that oscillates like a wave at a frequency exactly proportional to the applied voltage.

The process generates AC pulses in precisely measured voltage units over a range of audio frequencies. Arbitrary waveforms can be generated at different voltage levels for different applications. At low voltages (such as 2 millivolts), the new AC Josephson junction voltage standard improves measurement accuracy as much as 1,000-fold. Output voltage may be achieved by "nano-stacked" arrays of Josephson junctions, permitting programmable voltage standard integrated circuits with over 130,000 junctions on a single chip. The new AC instrument currently has a maximum output of 100 millivolts.

Applications

- **Metrology**
  A programmable voltage standard source
- **Low-voltage calibration**
  Significantly increases the measurement precision of industrial voltmeters, spectrum analyzers, amplifiers and filters
- **Cryogenic radar systems**
  Produces 'chirps' or low phase-noise carrier frequencies

Advantages

- **Low current measurements**
  Accurately measures AC at very low currents
- **Greater range**
  Can generate a variety of arbitrary waveforms for different applications

Abstract

A low noise accurate signal generator for a calibration system or a radar system includes a generator of a digital data stream having a predetermined frequency spectrum incorporated therein. A series connected array of Josephson junctions is coupled to and excited by the digital data stream to provide a stream of pulses with quantum mechanically accurate time integral. A low pass analog signal filter is coupled to the pulses of accurate time integral for extracting analog signals of the predetermined frequency spectrum. For radar applications, a low phase-noise local oscillator of a fixed RF frequency and the output of the filter are coupled to a signal mixer which outputs low phase-noise chirped RF signals for use in generating transmit pulses for the radar system whereby enhanced detection of targets in "clutter" can be obtained.

Inventors

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Citations

1. S.P. Benz, C.J. Burroughs, C.A. Hamilton, T.E. Harvey. U.S. Patent #6,236,344 "AC and DC bipolar voltage source using quantized pulses."

Related Items

- AC Josephson Voltage Standard- Progress Report
- Pulse-Driven Josephson Digital to Analog Converter
- AC-DC Transfer Standard Measurements and Generalized Compensation with the AC Josephson Voltage Standard
- Article: Road to AC Voltage Standard Leads to Important Junction

References

- Expired U.S. Patent # 5,812,078 issued 09-22-1998

- Docket: 96-004US

Status of Availability

This technology is available in the public domain.

Last Modified: 07/29/2011